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(19) Eur päisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 361 910 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89309867.3

(22) Date of filing: 28.09.89

(51) Int. Cl.[5] A61K 9/16

(30) Priority: 30.09.88 GB 8823082
05.04.89 GB 8907658

(43) Date of publication of application:
04.04.90 Bulletin 90/14

(84) Designated Contracting States:
AT BE CH DE ES FR GB GR IT LI LU NL SE

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(54) Granular pharmaceutical formulations.

(57) The invention provides a process for the preparation of granules comprising a pharmaceutical which comprises contacting a particulate, spray-dried substrate and a particulate pharmaceutical to obtain particles comprising a substrate core carrying an adsorbed pharmaceutical and contacting those particles with a particulate pharmaceutical and a melted or thermally softened pharmaceutically acceptable excipient which is solid at room temperature to obtain, after cooling to solidify or harden the excipient, granules comprising a spray-dried substrate core carrying pharmaceutically acceptable excipient and pharmaceutical.

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GRANULAR PHARMACEUTICAL FORMULATIONS

This invention relates to a novel, granular pharmaceutical composition, particularly suitable for use in dispersible formulations, and a process for its production.

Granulation is widely used for the production of pharmaceutical compositions and several basic process types can be distinguished, including dry, wet, and melt or imbedding techniques. A number of other processes can also be used including adsorption onto carriers (an example of which is the adsorption of drugs onto carbohydrates, such as lactose, for use in dry powder aerosols).

More particularly, it is known that certain pharmaceuticals, or combinations thereof, can be adsorbed onto spray dried sorbitols (e.g. Merck "Sorbit-Instant"; P.C. Schmidt & K. Benke "Drugs Made In Germany" (1985) vol.28 p.49-55). It is also known that other similar spray-dried materials, such as lactose and dextrose are capable of adsorbing certain substances (W.J. Thiel & L.T. Nguyen, J. Pharm. Pharmacol., 1984, 36, 145-152). The resultant particulate materials are stated to show a high level of physical stability in some instances. This particular adsorption appears to result from electrostatic interaction between adsorbent and adsorbate - potentiated by the open, three-dimensional network structure of the adsorbent.

We have now found that many other pharmaceuticals can also be readily adsorbed onto such substrates. However, in practice only relatively low levels of pharmaceutical can be adsorbed before the carrier is saturated. (In a typical case (that of ketoprofen on sorbitol) this is 7-8% by weight). Th pharmaceutical is also relatively exposed and this can be disadvantageous. This exposure can, for exampl , cause storage stability problems for sensitive pharmaceuticals, allow bitter or irritant pharmaceuticals to affect the oral or gastric mucosa upon ingestion, or result in metabolic inactivation before the pharmaceutical reaches the target site for absorption. In order to reduce this exposure it is often desirable to coat the particles.

Surprisingly, in view of a prior art statement that certain sorbitol-based particles can withstand the stresses imposed on them under air-jet sieving (and would hence apparently be stable to normal handling procedures), it has been found by others that, under related conditions, such as fluidisation, many are not stable. Furthermore, we have found that they also do not survive the coating processes used in industry to apply known film coatings (for example enteric soluble, sustained release or taste masking coatings) onto small drug particles. The vigorous agitation resulting from mechanical movement, spray pressure, or extraction air flow in these processes results in considerable breakdown and loss of active agent (which is only present at a relatively low level in any event) of up to 50%. It is also known that other similar spray-dried substrates tend to retain adsorbates less effectively than sorbitol when subjected to similar processing.

Any coating processes which are carried out on such particles also cause agglomeration and clumping, resulting in decreased efficiency and processing difficulties.

As a result of research and experimentation it has been found possible to stabilise adsorbed pharmaceutical on a spray-dried substrate core and also to incorporate additional pharmaceutical by using certain excipients which act as binders.

The invention therefore provides a process for the preparation of granules comprising pharmaceutical, which process comprises contacting a particulate, spray-dried substrate and particulate pharmaceutical to obtain particles comprising a substrate core carrying adsorbed pharmaceutical and contacting those particles with particulate pharmaceutical and a melted or thermally softened pharmaceutically acceptable excipient which is solid at room temperature to obtain, after cooling to solidify or harden the excipient, granules comprising a spray-dried core carrying pharmaceutical and pharmaceutically acceptable excipient.

It will be appreciated that a single pharmaceutical or a combination of pharmaceuticals may be used in any part of this process.

In a preferred embodiment of the invention an excess of particulate pharmaceutical is contacted with the spray-dried substrate to obtain a mixture of particles carrying adsorbed pharmaceutical and excess pharmaceutical, and a solid pharmaceutically acceptable excipient is added to the mixture which is heated to melt or soften the excipient and subsequently cooled to obtain particles carrying pharmaceutically acceptable excipient and pharmaceutical. In this embodiment the excipient is uniformly distributed throughout the mixture before heating which facilitates adherence of the excess pharmaceutical and excipient to the particles which already carry adsorbed pharmaceutical.

The invention also provides granules which comprise a spray-dried substrate core which carries adsorbed pharmaceutical and, in addition, a layer comprising a pharmaceutically acceptable excipient and pharmaceutical.

The pharmaceutical may be bound to the substrate surface by the excipient either physically (i.e. as individual "glued" particles), in solid solution, or by a combination of both means. The precise mode of retention depends on the properties of the excipient and pharmaceutical used.

Preferred substrates are spray-dried carbohydrates, for example sugars, such as lactose and dextrose, and sugar alcohols, such as sorbitol or mannitol. Spray-dried sorbitol is particularly preferred.

Preferred pharmaceuticals include anti-inflammatories such as ketoprofen [2-(3-benzoylphenyl)propionic acid] and indomethacin [1-(4-chlorobenzoyl)-5-methoxy-2-methyl-3-carboxymethylindole], bronchodilators such as salbutamol [2-t.butylamino-1-(4-hydroxy-3-hydroxymethylphenyl)ethanol], anti-allergics / anti-arthritics such as tetrazole-5-(3-acetyl-5-fluoro-2-hydroxy)carboxanilide [Compound (I)], sedatives such as zopiclone [6-(5-chloropyrid-2-yl)-6,7-dihydro-7-oxo-5H-pyrrolo[3,4-b]pyrazin-5-yl 4-methylpiperazine-1-carboxylate] and β-blockers such as acebutolol [N-{3-acetyl-4-(2-hydroxy-3-[1-methyl ethyl]aminopropoxy)-phenyl butanamide]. These can be used in the form of the compounds themselves or in the form of pharmaceutically acceptable salts (e.g. hydrochlorides of basic materials)

Suitable materials for use as the pharmaceutically acceptable excipient soften or melt between room temperature and the highest temperature at which the initially formed adsorbate/carrier particles are stable, typically 40-80 °C in the case of sorbitol based substrates. They are also capable of wetting both the initially formed particles carrying adsorbed pharmaceutical and the unadsorbed pharmaceutical whilst in the softened or molten state and preferably do not dissolve the substrate. They can be incorporated by a variety of methods provided that the temperature during at least part of the process is above the softening or melting temperature of the excipient or excipient mixture used.

Preferred excipients are lipids and waxes. Particularly preferred are fatty acids, especially stearic acid; carboxylate esters, especially those of glycerol, glycols and polyglycols (for example Gelucires such as Gelucire 64/02); polyethylene glycols; and mixtures thereof, optionally with other excipients.

Lipids and waxes are well known as binders in a variety of formulations and stearic acid is specifically known as a lubricant in numerous granulating and tabletting processes. The particular usage in the present invention is different from those previously described in that the pharmaceutical and the excipient are jointly adsorbed onto the substrate carrying the initial load of pharmaceutical and form a coherent layer as may be seen from Scanning Electron Microscope photographs of the final products.

Such photographs also show that the pharmaceutical is bound to substrate particles of all sizes. From a practical point of view it is, however, desirable only to use granules of a particular size or size range - normally above a certain minimum size - in final formulations. To facilitate this, it is advantageous to use substrate particles which are substantially larger than those of the pharmaceutical and which are also of approximately the required final size or size range. This also allows the ready removal of any unadsorbed materials or abraded substrate by sieving. Typically, substrate materials having a particle size of 150-1000μ (e.g. 250-500μ) and pharmaceutical with a particle size of less than 150μ (e.g. less than 100μ) are used. Such limits enable the separation of active granules from unwanted fine material by using a sieve, for example of 125 or 150μ.

The final composition of the granules depends upon a number of factors. For example, the amount of pharmaceutical will depend upon the drug potency and required dosage and upon the intended granule content of any final composition and the amount of excipient will depend upon the surface area and type of substrate and upon the nature of the pharmaceutical and excipient and their mutual interactions. Typical granules comprise 2-25%(w/w) pharmaceutical and up to 25%(w/w) excipient.

The granules may themselves be suitable for use without further processing, as the excipient can itself act as a dissolution retarding or enhancing, and/or taste masking agent, in addition to having an adsorbate stabilising action, and this may be all that is required.

Normally, however, the granules will be subjected to further treatment(s) and they are, for example, stable enough to be further coated to form, for example, enteric or sustained release products via various coating processes including spray or pour methods in apparatus such as granulators, or pan or fluid bed coaters.

The content of pharmaceutical in the coated granules indicates that essentially no loss occurs during the coating process (for example an 18-20% (w/w) active agent level is reduced by addition of the coating weight to 16-17% (w/w) when ketoprofen-containing granules are coated).

Coated and uncoated granules can both be used in the preparation of formulations such as sustained release, pulsed release and enteric products, for example in the form of tablets. They are however especially suitable for making formulations of the above types which are to be administered in the form of suspensions or dispersions.

Individually, both uncoated and coated granules will allow for a wide variability of release rate, depending on the choice of excipient(s) and coating material(s). Mixtures of coated and uncoated, or different types of coated or uncoated, granules will give pulsed, or other release pattern, formulations, as is known in the art.

It is also possible to use, in granules according to the invention, drug or drug-excipient mixtures which would otherwise not be physically or chemically compatible.

Dispersible formulations may contain further excipients including suspending agents such as sodium carboxymethylcellulose, acidulants such as citric acid or adipic acid, sweeteners such as acesulfame-K or aspartame, lemon or other flavourings, colouring agents such as titanium dioxide, and bulking agents such as sugar alcohols (e.g. mannitol or sorbitol) -- which may be of the spray-dried type, as well as other conventional excipients.

A typical final composition for a single dose of a dispersible formulation (in the case of coated, ketoprofen-containing granules having an active ingredient content of 15-20%(w/w)) is in the range:-

Granules	250-667mg
Suspending agent	100-150mg
Acidulant	50-75mg
Sweetener	10-30mg
Flavouring	0-30mg
Colouring	0-30mg
Bulking agent	q.s.

Tablets made from granules according to invention may be made by compression of the coated or uncoated granules, or mixtures thereof. They may also be made from mixtures containing further conventional excipients, such as disintegrants (e.g. optionally cross-linked sodium carboxymethylcellulose), bulking agents (e.g microcrystalline cellulose) and flow promoters and hardeners (e.g. silica) and may also contain other conventional granulations.

The following Examples illustrate the invention. Unless otherwise indicated all percentages are on a weight for weight basis.

Example 1

Preparation of granules

Ketoprofen B.P. (<100u.600g) and spray-dried sorbitol (Sorbit Instant Merck 3140;250-500u;1860g) were mixed using a Hobart mixer under gentle heating for 4 minutes. Stearic acid BPC powder (540g) was then added and stirring continued for a further 45 minutes during which period the temperature was raised sufficiently to melt the stearic acid. The mixture was allowed to cool under stirring for a further 35 minutes to give an essentially quantitative yield of granular product. Sieving of a sample showed that the 125-800u fraction (83.1% of the sample) had an active ingredient content of 18.9%

Example 2

Coating of granules

A spray coating solution was made by dissolving, with vigorous stirring, hydroxypropylmethylcellulose phthalate (Shin Etsu HP50; 640g) in a mixture of methylene chloride (3680g) and methanol (3680g).

400 grams of granules prepared as in Example 1 were placed in a fluidised bed chamber and gently fluidised by means of air containing a small amount of steam as a static eliminator.

500 grams of spray solution were then used to coat the fluidised granules via an atomising nozzle at a temperature of 20-40°C. Upon completion of spraying the granules were left fluidising for a further 5 minutes and then removed to yield 432g of coated granules. Sieving of a sample showed that the 150-800u fraction (93.0% of the sample) had an active ingredient content of 16.7%

Example 3

Proceeding in a similar manner to that of Example 1, granules were prepared from:-

Indomethacin B.P.(<100μ)	25g
Stearic acid BPC	56.4g
Sorbit Instant (250-500μ)	175g

The fraction above 125μ accounted for 99.3% of the sample and had an active ingredient content of 8.8%.

Example 4

Granules were prepared, using the method of Example 1, from:-

Salbutamol sulphate B.P.(<100μ)	6.25g
Stearic acid BPC	75g
Sorbit Instant (250-500μ)	231.25g

The fraction above 125μ accounted for 99.7% and had an active ingredient content of 2.0%.

Example 5

Granules were prepared, using the method of Example 1, from:-

Ketoprofen B.P.(<100μ)	50g
Gelucire 64/02	42g
Sorbit Instant(250-500μ)	150g

The fraction above 125μ was 97.6% and had an active ingredient content of 19.0%.

Example 6

A dispersible formulation was prepared as follows. Sorbit Instant (4786g) and titanium dioxide (208g) were blended in an Oblicone blender and 4846g of the resultant mix was further blended in the same device with:-

Aspartame	240g
Lemon-Juice Flav-O-Lok (flavouring)	80g
Citric acid	800g
Sodium carboxymethylcellulose	1200g
Coated granules (prepared as in Example 2)	4834g

The resultant formulation was filled into sachets each containing 100mg (nominal) of ketoprofen. (Total fill weight ca. 1.5g).

Example 7

Proceeding in a similar manner to that of Example 6, there was prepared a dispersible formulation consisting of:-

Coated, ketoprofen-containing granules (17.4% active content)	38.3%
Mannitol	43.3%
Sodium carboxymethylcellulose	10.0%
Adipic acid	5.0%
Titanium dioxide	1.7%
Aspartame	1.0%
Flavouring	0.7%

Examples 8 to 11

Proceeding in a similar manner to that of Example 1, the following granules were prepared and analysed:-

Example	Active ingredient	Weight	Excipient	Weight
8	Ketoprofen	75g	Polyethylene glycol 6000	45g
9	Compound (I)	30g	Polyethylene glycol 6000	45g
10	Zopiclone	5g	Stearic acid	20g
11	Acebutolol hydrochloride	10g	Stearic acid	20g

Example	Sorbitol weight	Fraction >125µ	Active ingredient of >125µ fraction
8	180g	99.9%	24.9%
9	225g	98.9%	9.2%
10	75g	100.0%	4.9%
11	70g	99.9%	9.4%

Example 12

Uncoated granules, prepared using the method of Example 1, with a ketoprofen content of 20.1%, were compressed using 0.5 inch tooling on a Manesty F3 single punch tabletting machine, to form hard tablets weighing 250 - 500 mg, with a waxy matrix type structure.

Example 13

Proceeding in a similar manner to Example 12, tablets were prepared from coated granules, prepared using the method of Exampl 2. These were very hard smooth tablets of waxy appearance.

Example 14

Dispersible 500 mg tablets were prepared, in a similar manner to Example 12, from a mixture of:-

Coated granules (prepared as in Example 2)	56%
Microcystalline cellulose	20%
Sodium carboxymethylcellulose (Ac-Di-Sol)	20%
Fumed silica (Aerosil 200)	4%

They were readily dispersible in water.

Claims

1. A process for the preparation of granules comprising a pharmaceutical which process comprises contacting a particulate, spray-dried substrate and a particulate pharmaceutical to obtain particles comprising a substrate core carrying an adsorbed pharmaceutical and contacting those particles with a particulate pharmaceutical and a melted or thermally softened pharmaceutically acceptable excipient which is solid at room temperature to obtain, after cooling to solidify or harden the excipient, granules comprising a spray-dried substrate core carrying pharmaceutically acceptable excipient and pharmaceutical.

2. A process according to claim 1 in which an excess of particulate pharmaceutical is contacted with the spray-dried substrate to obtain a mixture of particles carrying adsorbed pharmaceutical and excess pharmaceutical, adding to the mixture a solid pharmaceutically acceptable excipient, heating the mixture to melt or soften the excipient and subsequently cooling to solidify or harden the excipient.

3. A process according to claim 1 or 2, in which the substrate is lactose, dextrose, sorbitol or mannitol.

4. A process according to claim 1, 2 or 3, in which the excipient softens or melts at a temperature from room temperature to 40°C.

5. A process according to any one of the preceding claims, in which the excipient is stearic acid; a carboxylate ester of glycerol, a glycol, or a polyglycol; or a polyethylene glycol.

6. A process according to any one of the preceding claims in which the pharmaceutical is ketoprofen, which is 2-(3-benzoyl-phenyl)propionic acid, indomethacin, which is 1-(4-chloro-benzoyl)-5-methoxy-2-methyl-3-carboxymethylindole, salbutamol, which is 2-t.butylamino-1-(4-hydroxy-3-hydroxymethylphenyl)-ethanol, tetrazole-5-(3-acetyl-5-fluoro-2-hydroxy)carboxanilide, zopiclone, which is 6-(5-chloropyrid-2-yl)-6,7-dihydro-7-oxo-5H-pyrrolo[3,4-b]pyrazin-5-yl-4-methylpiperazine-1-carboxylate, acebutolol, which is N-{3-acetyl-4-(2-hydroxy-3-[1-methyl-ethyl]aminopropoxy)phenyl} butanamide, or a pharmaceutically acceptable salt thereof.

7. A process according to any one of the preceding claims, in which the granules prepared comprise from 2 to 25% by weight of pharmaceutical.

8. A process according to any one of the preceding claims, in which the granules prepared comprise up to 25% by weight of excipient.

9. A process according to any one of the preceding claims, in which the spray-dried substrate particles have a particle size from 250 to 500 µ, and the pharmaceutical particles have a particle size of less than 100 µ.

10. A process according to any one of the preceding claims in which the granules are subjected to a further coating step.

11. Granules which comprise a spray-dried substrate core carrying an adsorbed pharmaceutical and a layer comprising a pharmaceutically acceptable excipient and a pharmaceutical.

12. Granules according to claim 11, which are as defined in any one of claims 3 to 10.

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 89309867.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	EP - A2 - 0 094 116 (THE PROCTER & GAMBLE CO.) * Page 2, line 31 - page 6, line 5 *	1-3,5, 6,8-12	A 61 K 9/16
D,Y	JOURNAL OF PHARMACY AND PHARMACOLOGY, vol. 36, September 1984, London W.J.THIEL et al. "Fluidized bed film coating of an ordered powder mixture to produce microencapsulated ordered units" pages 145-152 * Page 146 *	1-3,5, 6,8-12	
A	AT - B - 385 654 (ARCANA) * Page 2, line 52 - page 4, line 38 *	1	
A	DE - A - 2 028 224 (SOLCO BASEL AG) * Claim 4 *	11,12	TECHNICAL FIELDS SEARCHED (Int. Cl.4) A 61 K 9/00
A	DIE PHARMAZIE, 34, vol. 12, December 1979, Berlin H.KALA et al. "Anwendung der Sprühtrocknung in der Pharmazie" pages 779-784 * Page 783, 2.5.1. *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	22-12-1989	IRMLER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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